CAD for Jewelry Artisans

First published in *Lapidary Journal Jewelry Artist*, November 2013

Love it or hate it, computer-aided design (CAD) and computer-aided manufacturing (CAM) are here to stay. Here's a basic introduction to CAD/CAM.

In 2006, the prescient Rebecca Strzelec, Professor of Visual Arts, Penn State University Altoona College, talking about the growing importance of computer-aided design, hazarded a guess that, in five to eight years (or about now) students would seek out schools and universities that specialized in CAD. "They'll be the first generation that will have no experience touching the material," she said. Was she ever right.

If you're in any kind of manufacturing world—and that includes jewelry making and design—you can't avoid the existence of CAD. You can hate it, or love it, or be ambivalently curious about it, but you can't ignore it. So what is this thing called CAD? Does it have anything for you?

The Choices

CAD—computer-aided design—comes in two flavors: two-dimensional and three-dimensional. The one most common in jewelry making, as you might guess, is 3D CAD. These programs allow you to sculpt jewelry without touching wax or metal by drawing lines in a simulated three-dimensional space.

Many CAD programs are based on Rhinoceros, or Rhino. This broad-based program is used for design in many industries, from automotive to medical to jewelry to power tools. However, there are industry-specific CAD programs, too, explains, Mark Maxwell, CMBJ, Manager of the Jewelry Manufacturing Arts Department at GIA in Carlsbad, CA, including those designed for the jewelry industry. Although GIA teaches GemVision's Matrix, based on Rhino, there are other jewelry-specific programs available,

such as RhinoGold; 3Design from Vision Numeric, and ArtCAM JewelSmith by Delcam. Some jewelers have used Space Claim Engineer and Autodesk, too, as well as more graphically oriented programs such as Z-Brush or Sculptris.

However, its wide-ranging, cross-industry use is one reason Rhino is often is taught in university design departments. “It’s more complex [than jewelry-specific software such as Matrix],” says Hyun Jong “Jay” Song, Jewelry and Objects Department Chair at Savannah College of Art and Design (SCAD) in Savannah, Georgia, “but the potential application is much greater than any other software.” Essentially, students can go into any industry when they leave school. In addition, says Song, “[Rhino is] the most popular 3D modeling program used in the [jewelry] industry, especially in Asia where most of the work is done.”

The Basic Skinny on CAD

There are two complementary parts to CAD: modeling is the part used to actually draw the design graphically; and rendering is the part of the program used to make the virtual model look “real” or photographic. Jewelry-specific programs, such as Matrix or 3Design, have rendering capability built in; Rhino requires a rendering plug-in. (A plug-in is a set of software components that adds specific capabilities to a larger software program.) Another popular plug-in for jewelry CAD programs is T-Splines which allows a user to make organic forms more easily.

Jewelry-specific programs have been structured to give you single-mouse-click ways to add stone shapes, setting styles (such as heads or bezels), and shanks; you can then change the thickness, height, and width to suit your design concept. Metal and stone colors are also only a click away. Rhino, designed for all kinds of industry, demands more attention to these details. Unless you design a reference file (which you can do) of basic

shanks, heads, and stone shapes first, each time you create a jewelry design in Rhino, you'll have to create it from shank to prongs.

But even jewelry-specific CAD programs are not point-and-click automatic. The computer adage GIGO—garbage in, garbage out--holds just as true here as elsewhere. At GIA, Maxwell has noticed students' tendency to overbuild, to try to work too much complexity into too small a space. This is because everything looks enormous on screen. "You can fill the monitor with a 2 mm element," he says. In class, they keep dial calipers on every desk. When student's start checking the actual size of their design against what it looks like on screen, "they begin to see just how small half a millimeter is," he says.

If you come to CAD from areas of jewelry making outside of casting, you can run into other design issues that become technical issues when it comes to production. "It's really important to understanding the manufacturing aspect of jewelry making," says Maxwell. "In addition to being a computer person, you also need to understand how metal files and sands, how stones are set." This will affect how easily—if at all—the cast piece can be finished. You should also understand metal flow during casting, or you may design areas that are too thin to fill or flow during casting. Because in the end, CAD is all about getting to producible, functional, wearable jewelry.

However, first your CAD design has to run the CAM file gauntlet.

Phil Renato, Chair of the Allesee Metals/ Jewelry Design Program at Kendall College of Art and Design of Ferris State University in Grand Rapids, Michigan, explains that one of the disappointments beginning CAD users experience is that "because we call it 'printing,' people think [3D printing] works as simply as an ink jet or laser printer. But how many times have you sent a file to the printer and had it tell you, "I can't print that. The data is irregular'? Not often," he answers his own question. "However, for 3D printing, the data has to be structured perfectly in order to print."

When beginners use professional level CAD software, though, they make a lot of mistakes. “The models may be so eccentric--missing parts and connections—that not everything is printable,” says Renato. Even if the CAM system does print out the model, it will likely be unusable.

To get your CAD to a CAM—computer-aided manufacturing—system, the file has to be converted from the design (.3dm) file into a printing (.stl file) in order to tell the mill or printer what to do. When you make this conversion (which most CAD programs will make), says Song, you’ll see where there are gaps in your design, that have to be closed before you can print the design correctly. This is your opportunity to see whether or not your model will cast correctly.

You can do this manually, by going back into your CAD file and reworking it, or you can use other software, such as Magics RP, by Materialise Software, that will help you do it. “Magics is brilliant at actually stitching together, curing and healing the CAD files,” says Maxwell. However, even better is finding a service bureau that has the software and offers “fixes” as part of their service.

As you design your model with CAD, you’ll also have to consider the support system the model will need when it goes to CAM. As the model is being cut or grown, it needs to be held in place by a structure. These are cut away after milling or printing. “Some CAD programs pre-build a generic support system,” says, Maxwell, “however, in general, people customize the supports. Each ring or pendant has a different geometry that drives the support system. So no one size fits all when comes to supports.”

Yikes! So Why CAD?

If you’ve never considered CAD before and have not talked to anyone who’s used it, your head is spinning right now: milling, printing, supports, resins, eccentricities, and weird file names. Is it worth trying to learn?

It could be—for several reasons:

Accuracy. If you work with wax or PMC or fabrication, and you've spent *hours* trying to straighten a line, get a curve right, or mirror one side of the model to the other, you might well come to love CAD. "The accuracy working straight in 3D is amazing," says Maxwell. "Doing things by hand, it's difficult to get the level of accuracy that you can with CAD."

Reduced costs. Although the initial cost to buy a CAD program can be steep (Rhino kicks off at about $1000, with plug- ins extra; jewelry-specific software can be much more; student discounts may be available through a trade school or university), that cost quickly flattens. First, there is no studio space or equipment to maintain. You can work on your dining table. Second, overhead is virtually nil. "The risks inherent in traditional metalworking are different from those inherent in using CAD," says Strzelec. Make piece of jewelry traditionally, and, if you don't sell it, you've lost time and money in metal and stones. Working in CAD, she says, "All I lose in working is time. And I can put the extra time that might have gone into preparing the metalsmithing studio, and repairing things, into the design of the object."

By using a rendering program to create a photorealistic image of your CAD design, you can sell virtually. "Lots of companies populate their websites with renderings," says Maxwell. "Not until someone says they want it, does the manufacturer make the product with CAM and send it out." No more money tied up in inventory that is not moving.

Speed and volume. If you are planning to design a line, CAD can be your friend. CAD allows you to "design and manufacture jewelry in a very efficient, stream-lined way," says Maxwell. "You can generate a lot more pieces in CAD than you can using traditional methods. Some of the large RP (rapid prototyping) machines can build 100 rings at time. Those with a 3-inch build plate can do 10 to 20 rings overnight," he says. And CAD allows

you to make significant design changes and edits during the process of creating. That doesn't happen when doing jewelry the traditional manufacturing processes of fabrication or wax carving and casting," says Maxwell.

Learning Curve

As you might expect, CAD takes time and hours of practice to learn. Using CAD, says Song, "is like using any tool." Even something as simple as a hammer is not learned in one day. "You have to learn what the Rhino tools will let you do. It takes time to learn how to manipulate them."

At SCAD, says Song, each class meets for five hours each week for 10 weeks. "To learn the basics and an understanding of how the program works, it takes about 20 hours," she says. By the end of the quarter (50 hours) the students can work with basic shapes to build designs. At GIA, says Maxwell, students in the 7-week classes "can come out with the ability to make fairly basic and simple pieces that are saleable." Complex setting styles and forms take longer to master. "It takes six months to a year of intense work to become a proficient modeler." When Tucson, Arizona, custom jeweler Lisa Krikawa, who works almost exclusively with virtual designs, hires a CAD tech, she considers 10,000 hours the minimum in acceptable experience.

You'll have to get training somewhere. Most software programs offer training online or at changing locations. Community colleges, jewelry trade schools, and universities, also teach CAD. (You won't be using jewelry-specific software at the community college or university level unless the school has a dedicated jewelry program.) "Teaching yourself CAD is possible but difficult," says Maxwell. "Just the idea of 3D can be hard to wrap your head around. I taught myself SolidWorks and it was a cumbersome experience."

Before the Plunge

Time, training, money, commitment…It's a lot to ask. But there are ways of "test driving" CAD before you commit.

"Before you get into buying software," says Maxwell, "some companies offer free versions, so you can try them out." For example, Rhino's free version lets you experiment with the program, you just can't save your designs.

There are also "hobby level" free or low-cost programs, such as the playful little TinkerCad, Google Sketch Up, and Autodesk 123D. (These are not for jewelry making but a way to get your feet wet in CAD.)

"The advantage [hobby level progams] have over Rhino, besides being free and easy to learn, is that all of them will produce printable models," says Renato. Though the programming is limited, it's structured so that you cannot make a non-printable model. And most of these sites link directly to a service provider so you can order your design and learn exactly how CAD connects to CAM. This will give you a good feel for whether or not you want to move up to something like Rhino or a jewelry-specific software.

So if it interests you at all, try a smaller, more "goof-proof" program. See if you can see a place for CAD in your hobby or business. Who knows? Your future with CAD may be closer than you think.

For more information, check out these websites: GemVision, www.gevision.com; 3Design, www.3design.us; SpaceClaim Corporation, www.spaceclaim.com; Autodesk 123D, http://usa.autodesk.com; Rhinoceros, www.rhino3d.com; TinkerCad, https://tinkercad.com.